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Derwent Abstract No.93-321484 & DE4210895A1

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(54) Rotary abrasive jet cutting tool for radial cutting of submerged metal pipework uses inflatable rings for immobilizing inside pipework

(57) A tool for radial or diametrical cutting of metal pipework 1, in particular submerged submarine pipework and those forming parts of oil platform support structures, the cutting being performed by high pressure projection of abrasive particles suspended in a vector fluid, comprises a body 2 which can be immobilized inside said pipework, and a rotary head 3 provided with a nozzle 5 for projecting a mixture of water and abrasive, said body including a first inflatable positioning ring 6 and a second inflatable positioning ring 7, each of said inflatable rings being toroidal and being constituted by an elastomeric membrane which defines a sealed cavity which is very flattened in cross section when deflated, and which has a thickness under pressure that is at least twice its deflated thickness. Use is for cutting pipework forming the support structures of oil platforms when dismembering or dismantling oil platforms. When the cutting operation is finished, the cutting tool and the cut tube is lifted to the surface by hoist 36 when lifting rings 8, 9 are inflated to cause cushions 38, 37 to bear against the inside wall of the tube.

FIG_1

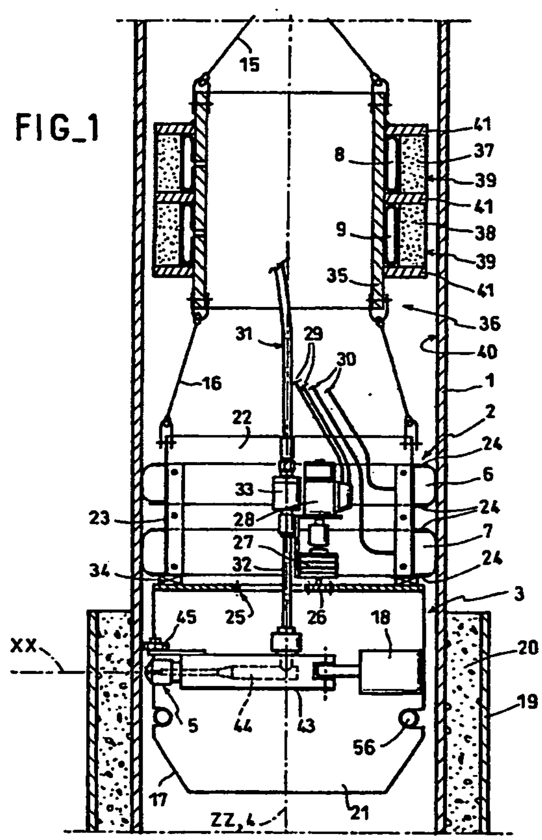

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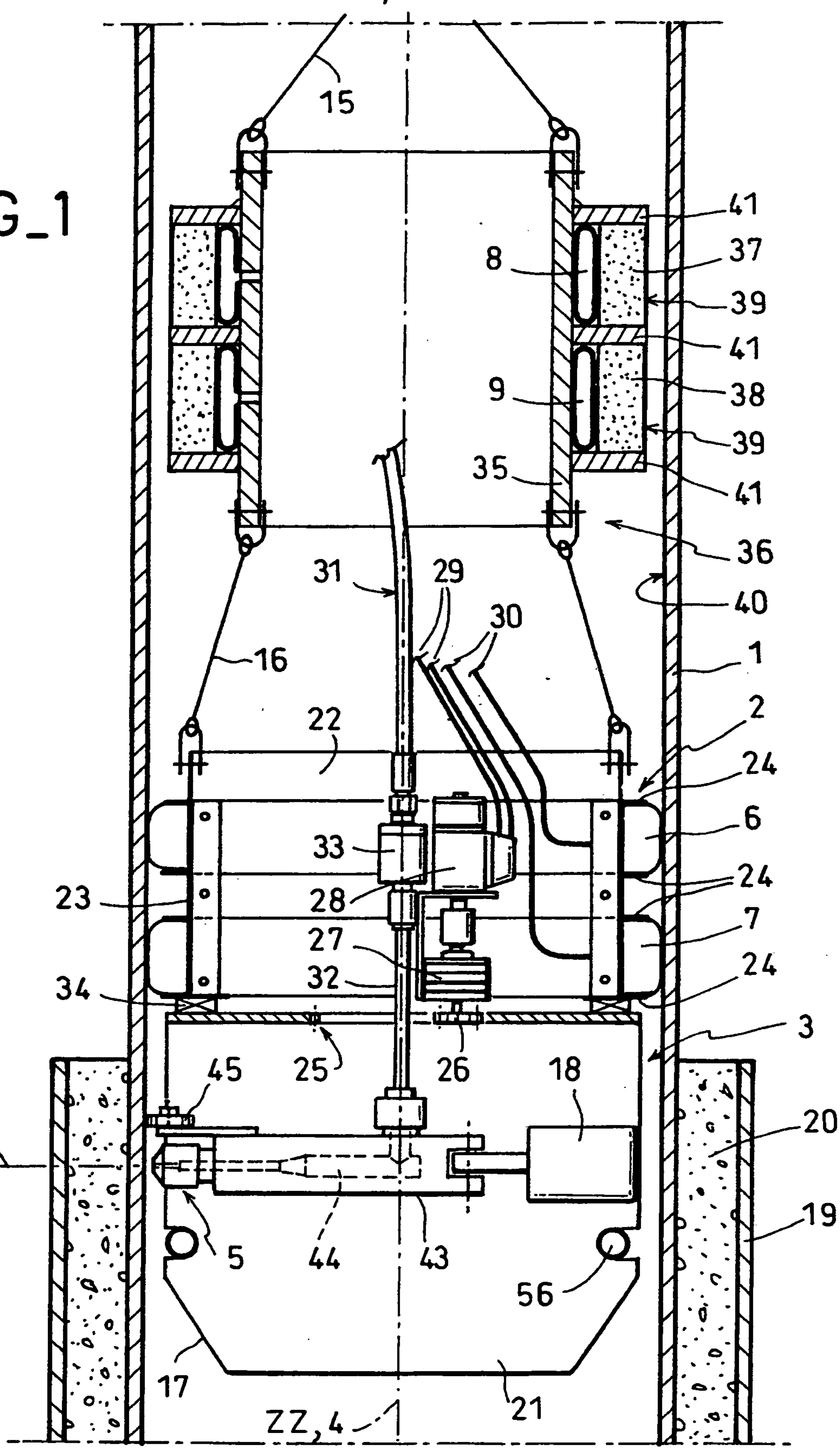
FIG_1



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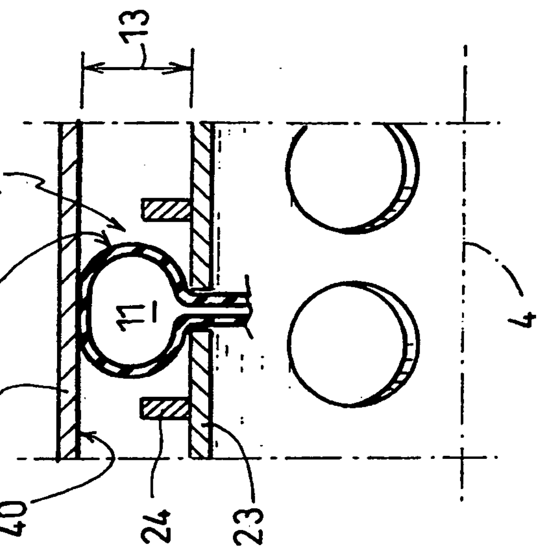


FIG_3

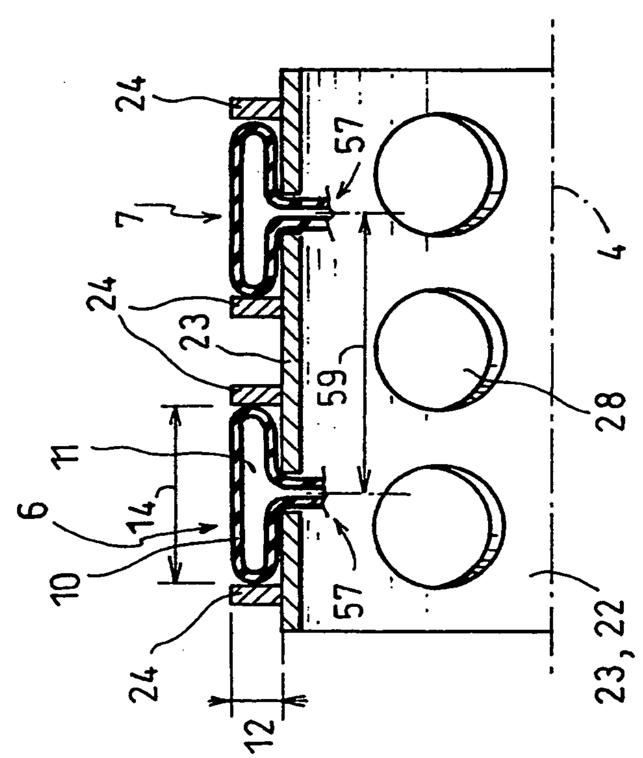
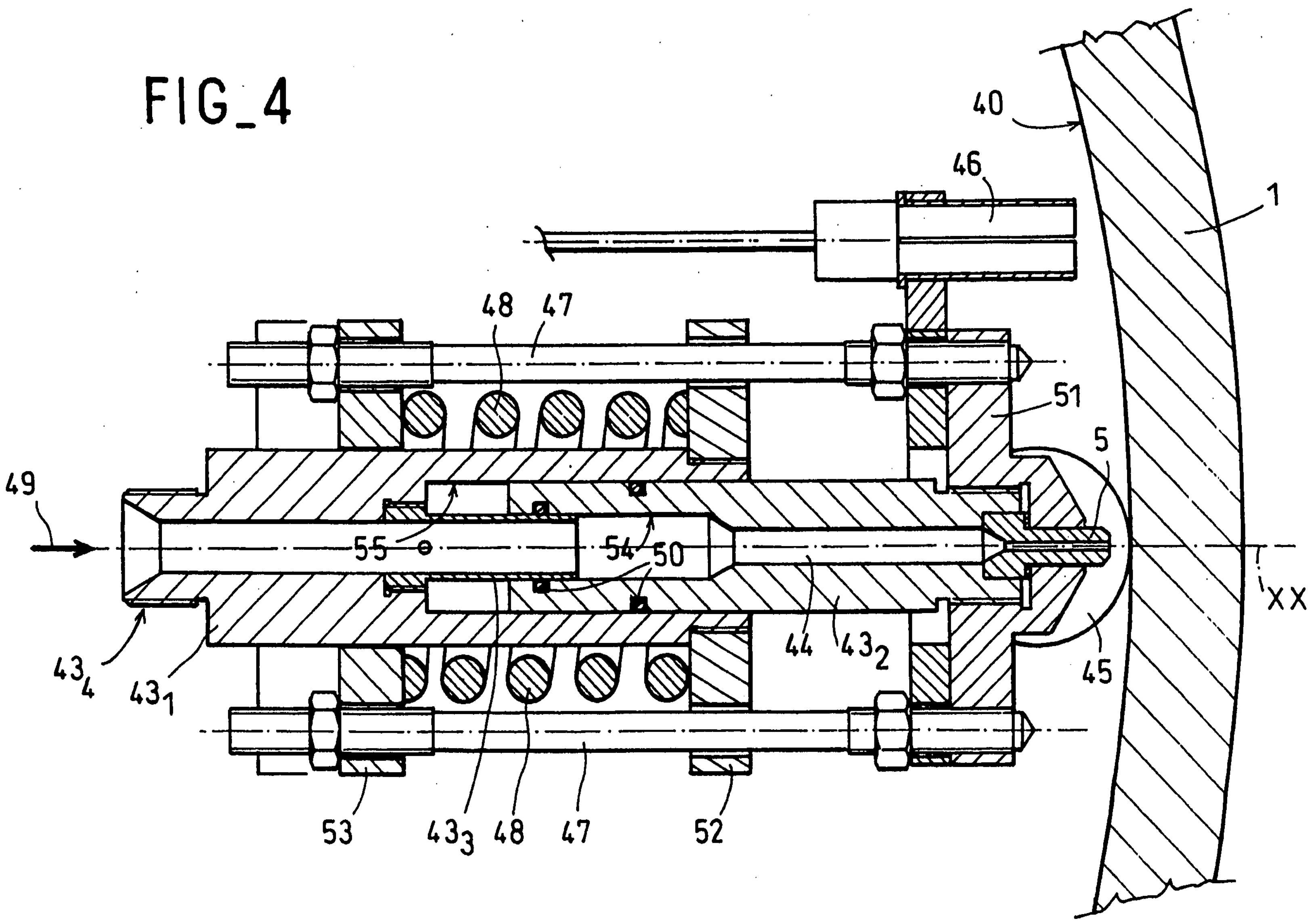


FIG_2

FIG_4



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ABRASIVE JET CUTTING TOOL FOR SUBMERGED PIPEWORK

The present invention concerns a tool for radial or diametrical cutting of pipework, in particular submerged submarine pipework (pipelines) and pipework forming the support structures of oil platforms, the cutting being performed by high pressure projection of abrasive particles suspended in a vector fluid.

The field of the invention is that of cutting tubes, in particular metal tubes.

BACKGROUND OF THE INVENTION

The pile base on which an oil platform rests is normally anchored to the sea bed and must be cut off when dismembering or dismantling the oil platform when operations are ended. This type of operation is generally carried out by inserting a tool for radial or diametrical cutting of the pile (or pipework) into the inside of a pile and cutting the pile using a high pressure abrasive jet.

European patent application EP-A-0 063 940 describes an abrasive jet cutting tool which can be inserted into the inside of a passage, the tool comprising a body, a head which is rotatably mounted relative to the body, and at least one cutting nozzle connected to a pressurized fluid source and fed with said pressurized fluid mixed with abrasive particles. The apparatus described in that document includes auxiliary nozzles for displacing the tool by using a fluid jet, i.e. by reaction, and it includes an annular inflatable collar which allows the apparatus to be positioned inside the pipework during the cutting operation.

The apparatus described in European patent EP-A-0 063 940 is intended for cutting tubes or piles, i.e. for cutting by using a jet of fluid which is charged with abrasive particles and in a direction which is parallel to the axis of the pipework into which it is inserted.

In order to cut pipework radially or diametrically, the tool must be positioned very accurately in the pipework to ensure that the pipework is cut properly; if the axis of the tool (in particular the axis of rotation of the tool head) is offset relative to the axis of the pipework, then a helical cut is produced after rotation of the head through one turn (360°), which hinders removal of the pipework sections and means that a true diametrical cut is not obtained.

OBJECTS AND SUMMARY OF THE INVENTION

The problem thus consists in providing cutting apparatus with improved positioning.

The problem also consists of providing cutting apparatus which can be maneuvered, positioned, and removed rapidly and as simply as possible within such pipework or platform support piles.

The problem is solved by providing a tool for radially cutting pipework using a pressurized abrasion jet, the tool being capable of penetrating into the inside of said pipework, said tool comprising a body which can be immobilized inside said pipework, and a rotary head provided with a nozzle for projecting a mixture of water and abrasive, said body including a first inflatable positioning ring and a second inflatable positioning ring, each of said inflatable rings being toroidal when pneumatically or hydraulically inflated, and being constituted by an elastomeric membrane which defines a sealed cavity which is very flattened in cross section when deflated (with a thickness of between 25 and 30 mm, for example), and which has a thickness under pressure that is at least twice the deflated thickness.

If required, the rotary head can be provided with two diametrically opposed projection nozzles which can be used simultaneously, or one can be used when the other is defective, each being fitted with separate remotely-controlled feed switching means, so that one or the other can be used in the event of one of the nozzles being

blocked and without the need for local manual intervention.

In addition, when the tools are to be used to cut tubes of very large diameter for example, it may be desirable to provide at least a third inflatable ring which is substantially identical to the first and second inflatable rings.

A preferred embodiment of the invention consists of a tool (in particular a submarine tool) for diametrical or radial cutting of pipework (in particular submerged pipework) using a pressurized abrasive jet, said tool comprising a first part or body termed the fixed part, i.e. which can be immobilized inside said pipework, and a second part or head, termed a movable or rotary part, i.e. which can be rotated relative to said first fixed part about an axis which is substantially identical to the longitudinal axis (ZZ) of said pipework, said movable part being provided with a projection (or delivery) nozzle for an abrasive mixture (normally containing abrasive particles in suspension in a fluid, preferably a liquid), said first part including a first inflatable positioning ring for positioning said tool in said pipework, said tool further including a second inflatable positioning ring for said tool, said inflatable rings being substantially toroidal and identical, and constituted by respective elastomeric membranes, preferably reinforced with textile or mineral fibers, each of said membranes defining a sealed cavity which is substantially toroidal or annular in shape, the cross section of which, when inoperative (in the deflated state), is very flattened, and the thickness of which, when pressurized (in the inflated or expanded state, at low pressure, of the order of several bars or hundreds of kilopascals, for example), is at least twice its thickness when inoperative.

The invention ensures very accurate positioning of said tool in said pipework (in terms of being parallel

and centered, or coaxial), for example accuracy of about 5 mm to 10 mm, and the inflatable rings can dilate or expand (during inflation under pressure) to a large extent as well as retract (or radially contract) during positioning or extraction of the tool in the pipework.

The ratio between the height of the (deflated) cross section to the thickness of the (deflated) cross section is preferably greater than 2, for example about 5 to 15, and the thickness of the deflated cross section is very small, preferably less than or equal to 100 mm, for example about 10 mm to 50 mm.

Advantageously, the tool further includes at least one, for example two, inflatable rings for lifting the section of pipework which is cut by the tool, the inflatable lifting rings preferably being positioned around a tubular body of a hoist and being positioned between flanges around the tubular body.

Advantageously, the inflatable lifting rings are surrounded by a deformable ring or cushion of generally toroidal shape, for example of substantially rectangular cross section, in which the substantially cylindrical outside surface has a high coefficient of friction with the inside surface of the passage.

The body (and/or head) advantageously comprises a pierced collar (containing cutouts or windows).

The tool advantageously includes a pipe, preferably a flexible hose, for feeding abrasive to the nozzle, which pipe is fixed relative to the body of the tool; the tool comprises a rotary coupling and a rotatable flexible hose (for feeding abrasive to the nozzle) connected to the outlet of the rotary coupling and to a feed tube for the nozzle provided in the head, the flexible feed hose being capable of turning about said axis simultaneously with the head and/or nozzle; the nozzle is preferably movable and can be displaced radially, for example by the action of a actuator, the head also comprising a roller bearing or roller which can roll on the inside surface of

the pipework to be cut, the head further including means for return movement of the nozzle.

Advantageously, the hoist and body of the tool are connected by flexible connectors such as slings, preferably of adjustable length; alternatively, the hoist and body can be rigidly connected together or constitute a single, mechanically rigid assembly.

The distance between the diametrical mid planes of the first and second inflatable positioning rings is advantageously not less than the width (or height) of the inflatable positioning rings.

The tool is advantageously fed with fluid at high pressure charged with abrasive particles, preferably between 100 bars and 2000 bars (or hundreds of kilopascals).

The movable nozzle is advantageously subjected to a bearing force, exerted for example by the fluid charged with abrasive particles, which urges the nozzle against the inside surface of the pipework. It is preferably also subjected to a return force (or balancing force along the same line but in the opposite direction to the bearing force), exerted by a spring or an actuator, for example.

Advantageously, the inflatable positioning rings surround a thin cylindrical tubular portion or collar of the body, the collar being provided at its periphery with substantially circular flanges situated either side of each of the inflatable positioning rings.

Due to the presence and the particular structure of the inflatable positioning rings in the tool of the invention, the reaction pressure on the tool body caused by inflation of the inflatable rings to lock the tool in position in the pipework is greatly reduced because of the large bearing area between the inflatable rings and the tool body. The structure of the body can thus be made lighter and is much easier to maneuver because of the reduced mechanical stresses.

In addition, due to the very high elasticity and deformability of the inflatable positioning rings of the invention, insertion and retraction of the tool in the pipework (when the inflatable rings are deflated) is greatly facilitated.

Further, the invention means that cutting tools (for example for tubes with diameters of about a foot to several meters) can be centered with their general axis of symmetry in almost perfect alignment with the longitudinal axis of the pipework to be cut, with an accuracy or tolerance on coincidence of the axes being of the order of about 5 mm.

Still further, in the preferred embodiment where the tool includes a pneumatic or a hydraulic hoist, maneuvering the tool together with a cut section of pipework is greatly facilitated by using inflatable lifting rings, and is still further facilitated when peripheral cushions are used which have a high coefficient of friction, facilitating maneuvering of the cut section of pipework.

The features of the invention, in particular the flexible feed hose for the fluid charged with abrasive particles which is rotatably mounted relative to the primary flexible feed hose by means of the rotary coupling and the radially movable nozzle, mean that a high-precision cut can be obtained.

BRIEF DESCRIPTION OF THE DRAWINGS

The numerous advantages of the invention will be better understood from the following description which refers to the accompanying drawings which illustrate non limiting embodiments of a cutting tool of the invention.

Figure 1 is a longitudinal section of a cutting tool provided with a pneumatic hoist in accordance with the invention, the section being on a plane including the common longitudinal axis of symmetry of the apparatus and of the pipework to be cut.

Figures 2 and 3 are respective diagrammatic fragmentary sections showing the operation of the inflatable positioning and lifting rings in a tool of the invention.

Figure 4 shows a detail of a particular embodiment of a movable nozzle in accordance with the invention.

MORE DETAILED DESCRIPTION

Referring to Figure 1, a cutting tool of the invention comprises a body 2 of substantially cylindrical shape with an axis 4 which must remain substantially coaxial with the longitudinal axis ZZ of the tube or pipe 1 during cutting of the tube (or pipe) 1, which may for example be made of metal. The tool comprises head 3 which is rotatable relative to body 2. Tube 1, which may be the base of an oil platform support pile, may for example be mounted inside an external pillar 19, which may be made of metal and which has been secured to the pile by cement 20 poured between the two tubes 1 and 19. Tube 19 may or may not be anchored in the sea bed.

Cutting tool 2, 3 is suspended by slings 16 from hoist 36 which may itself be suspended by slings 15 from the hook of a lifting means (not shown); the assembly constituted by the cutting tool and the hoist 36 has been inserted into tube 1 via its top end and has been lowered to the level at which the diametrical cut is to be made through the tube 1 (and optionally through tube 19 and through the cement filler) by the action of an abrasive jet projected by nozzle 5 in a radial direction (with reference to tubes 1, 19), i.e. along an axis XX shown in Figure 1, nozzle 5 being rotated about axis ZZ of said pipe 1 to effect the diametrical cut (at a rate of one revolution in 4 to 6 hours, for example).

In the position shown in Figure 1, the cutting tool is in the cutting position and is immobilized and centered in tube 1 by two inflatable rings 6, 7 located around a cylindrical portion or collar 23 (for example of

sheet metal) forming part of the fixed body 2 of the tool.

A large diameter bearing 34 is provided at the bottom end of body 2 to allow head 3 to rotate relative to body 2 about said pipe axis ZZ which is substantially identical to axis 4 of the body and/or head of the cutting tool.

Rotation can be effected by means of hydraulic motor 28 which is fed with driving fluid via flexible hose 29. Motor 28 rotates, e.g. via a coupling, one or more step-down gears 27 whose final output shaft carries a pinion 26 which engages with an annular gear 25 which is rigidly connected to head 3, thus rotating the head about axis 4, ZZ.

Head 3 comprises a structure, for example a metal structure, constituted by tubes 56 and a metal frame 21 on which an actuator 18 is fixed which can displace the nozzle fixed to the end of tube 43 defining a delivery conduit or channel 44 for the fluid charged with abrasive particles, allowing fluid to be fed to the nozzle.

Channel 44 is angled and comprises a substantially longitudinal portion situated along axis 4 and a radial portion along axis XX; the input to tube 43 and/or conduit 44 is connected to flexible hose 32 fixed at its bottom end to tube 43. High pressure flexible hose 32 can turn at the same rate as head 3 because of rotary coupling 33.

The input of coupling 33 is connected to flexible feed hose 31 for feeding the high pressure fluid charged with abrasive particles.

At the outer tangential or radial end of tube 43, close to nozzle 5, a roller 45 is provided which can bear and roll on the inside surface 40 of tube 1 and maintain a set gap or distance between the end of nozzle 5 and the wall, appropriate for the operation being carried out. Actuator 18 urges the nozzle radially, forcing roller 45 against inside wall 40 of the tube.

Actuator 18 can be constituted by a single-acting hydraulic cylinder with spring or accumulator return; alternatively, and as described below with reference to Figure 4, the actuator can be constituted by a mechanical actuator instead of a hydraulic cylinder, which means that the flexible hydraulic feed hose to actuator 18 can be omitted.

Inflatable positioning rings 6, 7 are fed with an inflating fluid which is transported by flexible feed hoses 30 (shown in part), each inflatable ring 6, 7 being fastened between two circular flanges 24 fixed on the outside surface of collar 23 and holding inflatable rings 6, 7 in position. The outside surface presses against inside surface 40 of tube 1 on inflation and the rings deform under the pressure of the fluid injected via flexible hoses 30.

It can also be seen in the top of Figure 1 that hoist 36 is mainly constituted by tubular body 35 having a hollow inside and three flanges 41, for example circular flanges, which define two annular spaces, each of which contains an inflatable lifting ring 8, 9 which can be fed by the same means as the inflatable positioning rings 6, 7 (but inflation limits are not shown).

Advantageously, inflatable lifting rings 8, 9 are surrounded by respective cushions 37, 38, which are annular in shape, substantially compact and relatively incompressible, and having outside surfaces 39 with a high coefficient of friction against the inside surface of tube 1 to facilitate locking of the hoist in the tube. Once the cutting operation is finished, the hoist can be used to lift both the cutting tool and the cut tube to the surface due to the pressure exerted by lifting rings 8, 9 which are inflated, causing the outside surface of cushions 38, 37 to bear against the inside wall of the tube and allow the cut tube to be lifted.

Referring now to Figure 2, collar 23, which constitutes an essential part of the frame of the body of the cutting tool, can be reduced in weight by making cutouts or windows 28 therein. Inflatable positioning rings 6, 7 are provided at its periphery.

Each ring is toroidal in shape and is mainly constituted by a membrane 10 which is preferably made of an elastomer reinforced with mineral or textile fibers to provide it with high elasticity, large radial dilation capacity and good elastic memory to enable it to return to its initial or deflated position each time the inflatable ring is deflated. The membrane defines a sealed cavity 11 provided with an orifice or valve 57 which connects the cavity and/or inflatable ring to an inflation tube (30 in Figure 1) to allow inflation and deflation of rings 6, 7.

Each ring extends around the periphery of collar 23 between two circular flanges 24 whose height substantially corresponds to the deflated height (i.e. in the absence of inflation pressure) of inflatable rings 6, 7, which height is very small relative to the deflated height (or width) 14 of the inflatable rings.

Figure 3 shows inflatable ring 6, 7 which has been pressurized and in which a portion of the outside surface of membrane 10 is in contact with inside surface 40 of tube 1. It can be seen that, due to its radial elasticity, inflatable ring 10 has deformed under the influence of the fluid injected into cavity 11 and has made contact with and pressed itself against the inside surface 40 of tube 1. The height 13 or radial thickness of rings 6, 7 is large relative to the deflated height 12 (Figure 2), preferably at least twice the height.

Figure 4 shows a preferred embodiment of a movable nozzle in an apparatus of the invention. Nozzle 5 can be held close to inside surface 40 of tube 1 by means of the construction shown in this figure; the construction comprises a tube 43_1 whose rear end 43_4 is connected, for

example, to rotatable flexible hose 32 (Figure 1) which means that fluid charged with abrasive particles is fed in the direction of arrow 49 to the channel inside tube 43_1.

The central portion of tube 43_1 comprises a thin tube 43_3 fixed to tube 43_1 via its upstream end portion (to the left in Figure 4), about which a movable tube 43_2, provided with seals 50, can slide in a bore 55 provided in tube 43_1; the downstream end of tube 43_2 (to the right in Figure 4) carries delivery nozzle 5 for the fluid charged with abrasive particles, and is fixed to a flange 51 fixed in turn to a roller 45 which can bear against and the inside surface 40 of tube 1 and roll slowly thereover as the tool head rotates about the longitudinal axis of tube 1. Flange 51 also carries an ultrasound detector 46 which monitors the cut.

Flange 51 also receives the ends of threaded rods 47 which pass through a flange 52 which is fixed relative to the tool head. The other end is connected to a flange 53 which can slide on abrasive fluid delivery tube 43_1; a helical compression spring 48 is provided around tube 43 and acts between fixed flange 52 and sliding flange 53. It operates as follows: the pressure of the fluid charged with abrasive particles tends to force the nozzle against inside wall 40 of tube 1 until the roller makes contact with the wall. This compresses spring 48 via flange 51, rods 47 and flange 53, and thus causes a return force to act on the nozzle; tube 43_1 is also forced (to the right in Figure 4) under the pressure of the vector fluid charged with abrasive particles. Tube 43_1 is retained by a shoulder which bears on flange 52.

A system is thus provided which accommodates small departures from true coaxiality between the axis of the tool head and the axis of the tube to be cut, and an apparatus is provided which ensures a substantially constant contact pressure of the roller against the inside wall of the tube and consequently ensures that the

distance between the nozzle outlet and the wall to be cut is constant.

As shown in Figure 1, it can be seen that the first and second inflatable rings (for positioning and/or lifting) are one above the other, their respective planes of symmetry being substantially parallel to each other (and perpendicular to axis ZZ).

CLAIMS

1. A tool for radially cutting pipework using a pressurized abrasion jet, the tool being capable of penetrating into the inside of said pipework, said tool comprising a body which can be immobilized inside said pipework, and a rotary head provided with a nozzle for projecting a mixture of water and abrasive, said body including a first inflatable positioning ring and a second inflatable positioning ring, each of said inflatable rings being toroidal and being constituted by an elastomeric membrane which defines a sealed cavity which is very flattened in cross section when deflated, and which has a thickness under pressure that is at least twice its deflated thickness.

2. A tool according to claim 1, further comprising at least one inflatable lifting ring disposed around a tubular body of a hoist.

3. A tool according to claim 2, wherein said inflatable lifting rings are surrounded by respective deformable rings each having an outside surface which has a high coefficient of friction against the inside surface of said pipework.

4. A tool according to any one of claims 1 to 3, wherein said body and/or said head includes a perforated collar.

5. A tool according to any one of claims 1 to 4, including an abrasive feed pipe which is fixed relative to said body of said tool, including a rotary coupling and including a flexible rotatable feed hose for said nozzle connected to the output of said rotary coupling and to a feed tube provided in said head, in which tube said nozzle is radially movable.

6. A tool according to any one of claims 2 to 5, wherein said hoist and said body for said tool are connected by flexible connections.

7. A tool according to any one of claims 1 to 6, wherein the distance between the diametrical mid planes of said first and second inflatable positioning rings is at least equal to their width.

8. A tool according to any one of claims 1 to 7, fed with fluid charged with abrasive particles at a pressure of more than 100 bars.

9. A tool according to any one of claims 1 to 8, wherein said movable nozzle is subjected to a force which urges it against the inside surface of said pipework and to a return force acting on the same line but in the opposite direction to the bearing force.

10. A tool according to any one of claims 1 to 9, wherein said inflatable positioning rings surround a thin tubular portion, or collar, of said body, said collar being provided at its periphery with substantially circular flanges situated either side of each of said inflatable positioning rings.

11. A tool for radially cutting pipework substantially as herein described with reference to and as illustrated in the accompanying drawings.

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Patents Act 1977
Examiner's report to the Comp[redacted]ller under Section 17
(The Search report)

Application number
GB 9[redacted]84.3

Relevant Technical Fields

(i) UK Cl (Ed.N) B3D (DBB, DBR, DBG, DBX); F2P (PG1)

(ii) Int Cl (Ed.6) B24C 1/04, 3/32, 5/02; B23Q 9/00, 9/02, 1/28; F16L 55/18, 00; E21B 29/00, 29/12

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii) ONLINE: WPI

Search Examiner
M J INSLEY

Date of completion of Search
15 JUNE 1995

Documents considered relevant following a search in respect of Claims :-
1-11

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one of more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages	Relevant to claim(s)
A	GB 2236065 A (SUBOCEAN PROJECTS) see whole document	
A	GB 2243428 A (INTERNATIONAL PIPELINES) see Figure 1	
A	EP 0063940 A (UNIPUMP) see whole document	
A	US 4529008 A (AMKPIPE) see column 5 lines 20-30	
A	US 4508129 A (GEORGE T. BROWN) see Figure 2	
A	US 4434815 A (KENNEDY J CIVIL ENG) see column 2 lines 61-68	
A	Derwent Abstract Accession No. 93-321484 & DE 4210895 A1 (ALBA) see the Abstract	
A	US 4191255 A (LOR) see whole document	
A	US 3782459 A (TRI-STATE) see whole document	

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